Nuclear Energy University Programs

Nuclear Energy Enabling Technologies (NEET) Program Overview

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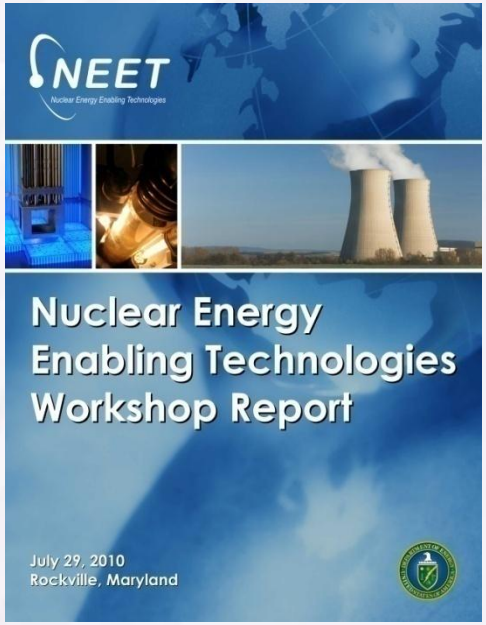
Program Objectives

Goal: Address critical technology gaps relevant to multiple reactor and fuel cycle concepts

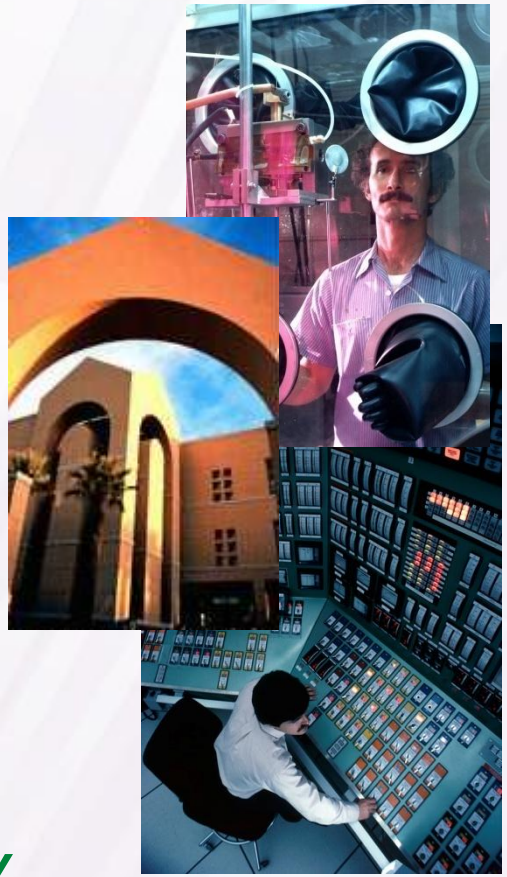
Objectives:

- Conduct research to develop crosscutting technologies that directly support and complement the Office of Nuclear Energy's development of new and advanced reactor concepts and fuel cycle technologies
- Encourage the development of transformative, "out-of-the-box" solutions across the full range of nuclear energy technology issues
- Focus on innovative research relevant to multiple reactor and fuel cycle concepts that offer the promise of dramatically improved performance



Program Elements

- **Crosscutting Technologies**
  - Reactor Materials
  - Proliferation and Terrorism Risk Assessment
  - Advanced Sensors and Instrumentation
  - Advanced Methods for Manufacturing
  - Nuclear Energy Advanced Modeling and Simulation (NEAMS) (FY 2012)
- **Energy Innovation HUB for Modeling & Simulation**
- **Transformative Nuclear Energy Concepts (FY 2012)**
- **National Science User Facility (FY 2012)**



Crosscutting Technologies

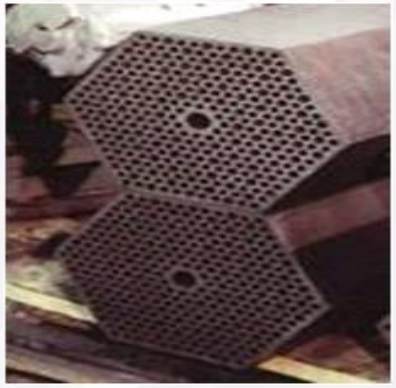
Provides support to various reactor and fuel cycle technologies:

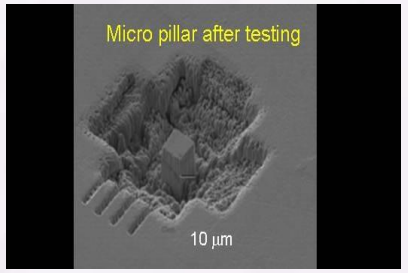
- Reactor Materials
  New classes of alloys and materials not yet considered for reactor performance may enable transformational reactor performance.
- Advanced Sensors and Instrumentation
  Research on unique sensor and instrumentation infrastructure technology to monitor and control new advanced reactors and small modular reactor systems.
- Advanced Methods for Manufacturing
  Research on advanced manufacturing technologies that draw upon successful practices in oil, aircraft, and shipbuilding industries, as appropriate, and employ modeling and simulation capabilities.
- Proliferation and Terrorism Risk Assessment
  Develop new tools and approaches for understanding, limiting, and managing risks of proliferation and physical security for fuel cycle and reactor system options.
- Nuclear Energy Advanced Modeling and Simulation (FY 2012)
  Develop advanced modeling and simulation tools and methods that focus on the next generation of technologies.

Reactor Materials

Envisions three main thrusts to support materials research:

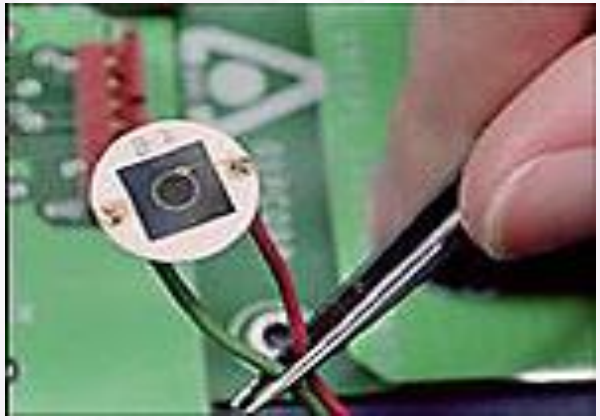
- Development of Innovative Materials
  - **Competitively awarded grants for great ideas (alloy development, techniques, and computations)**
  - **“Out of the box” thinking and materials**
- Promote Modern Materials Science Tools
  - **Deploy and expand use of new tools**
  - **Broader tools for all NE Materials efforts**
- Enhance collaboration and cooperation
  - **Increased communication between agencies**
  - **Promotion of international cooperation**





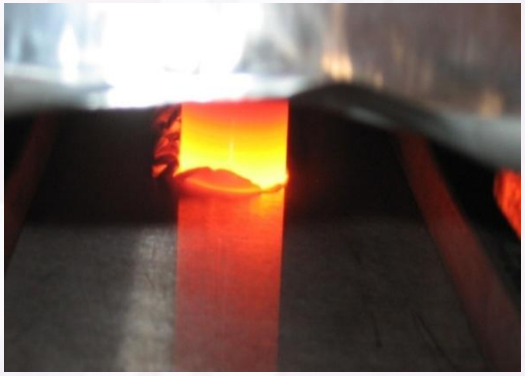
Advanced Sensors and Instrumentation

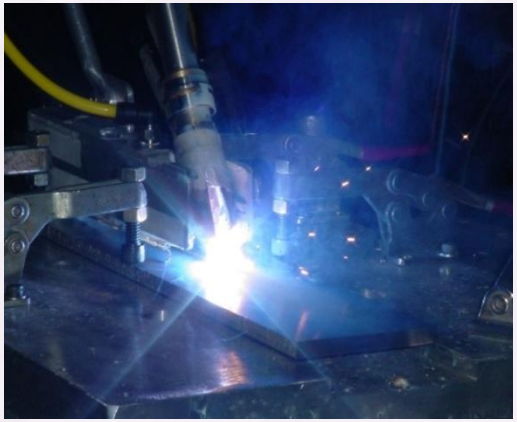
- R&D to address the unique sensor, instrumentation, and related technology needs to monitor and control new advanced reactors, small modular reactor systems, and fuel cycle facilities
- Research goals:
  - **Novel measurement capabilities**
  - **Adaptive and resilient digital monitoring and control**
  - **Robust communication technologies and architectures**
  - **Intelligent automation and adaptive interface capabilities**



Advanced Methods for Manufacturing

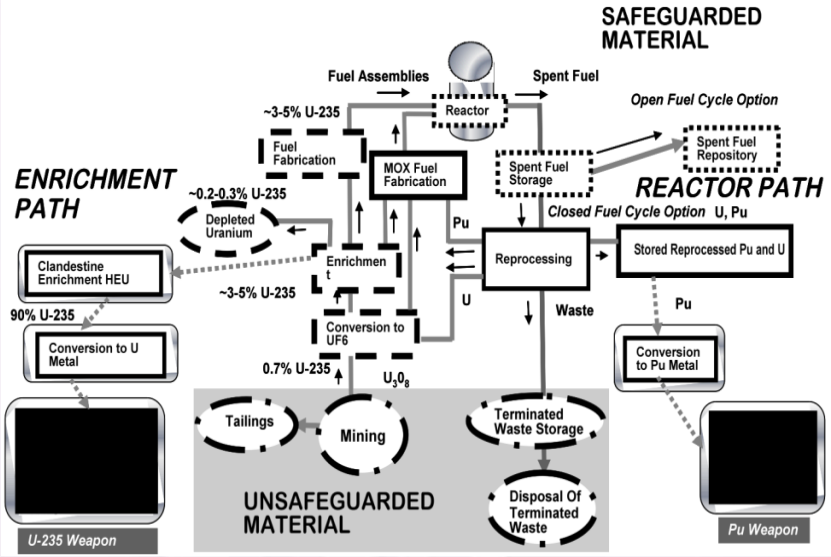
- Reduce the construction schedules and cost of power plant components, both in terms of basic materials cost as well as in the increase of shop fabrications activities versus field fabrication activities
- Will employ modeling and simulation to validate and optimize new technologies
  - **Modeling tools and techniques have improved significantly in recent years, and the ways in which we can link model information to the full building cycle is the one aspect of modern nuclear construction that differs substantially from past approaches**
- Technologies to be evaluated may include:
  - **Hybrid gas metal arc and laser welding**
  - **Automated Non-Destructive Examination Techniques**
  - **Prefabricated modular rebar assemblies**
  - **Self –compacting concrete**
  - **Standardized base-isolation design**





Proliferation and Terrorism Risk Assessment

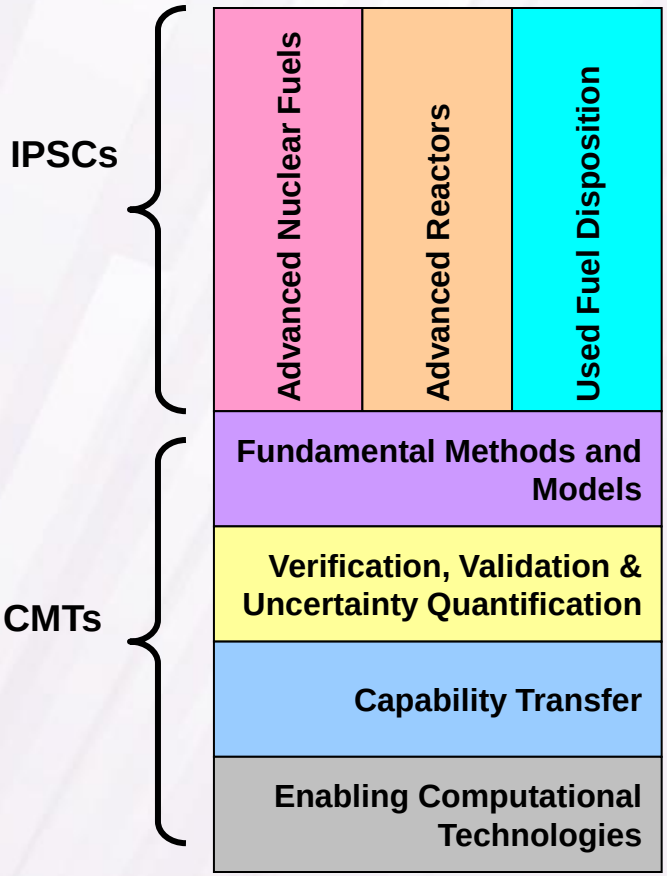
- New tools and approaches
- Focus on approaches necessary to inform the development of domestic fuel cycle and reactor technologies
- Assessments will:
  - **Be science-based approaches for analyzing difficult-to-quantify proliferation risk factors or indicators**
  - **Evaluate the diverse decision factors to compare different fuel cycle options**
  - **Apply tools to study nuclear energy system options**
  - **Produce results useful to decision makers**



tScott F. Demuth, Proliferation Resistance and Safeguards, in Handbook of Nuclear Engineering, Volume 5, p. 3421, Springer 2010

NEAMS Program

- **Integrated Performance** and **Safety Codes (IPSC)**
  - Continuum level codes that will **predict** the **performance** and **safety** of nuclear energy systems technologies
  - Attributes include 3D, science based physics, high resolution, integrated systems
  - Long-term development horizon (~10 years)
  - Codes with verification, validation and error uncertainty quantification
  - Using interoperability frameworks and modern software development techniques and tools
- **Crosscutting Methods and Tools**
  - Develop crosscutting (i.e. more than one IPSC) required capabilities
  - Provide a single NEAMS point of contact for crosscutting requirements (e.g. experimental data, computer technologies)
  - Smaller, more diverse teams to include laboratories, universities and industries.
  - "Tool Development" with shorter timelines

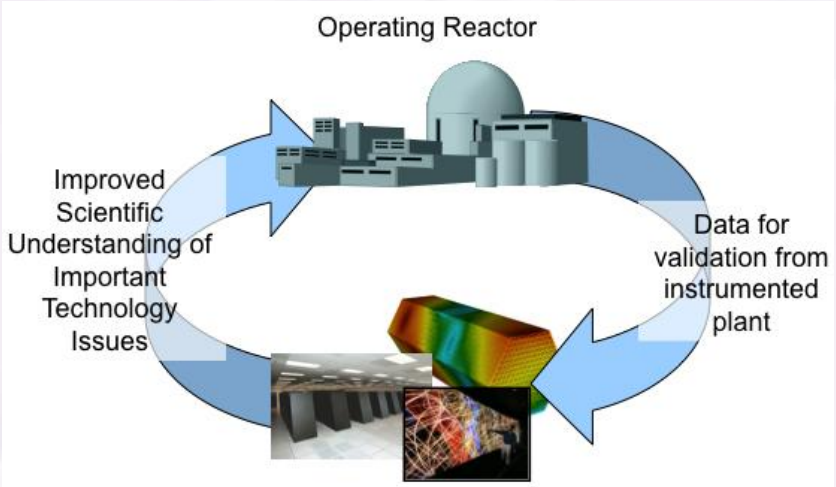


NE Modeling and Simulation Energy Innovation Hub

Consortium for Advanced Simulation of Light-water-reactors

- **A Different Approach**
  - **"Multi-disciplinary, highly collaborative teams ideally working under one roof to solve priority technology challenges" – Steven Chu**
  - **Characteristics**
    - **Leadership – Outstanding, independent, scientific leadership**
    - **Management – "Light" federal touch**
    - **Focus – Deliver technologies that can change the U.S. "energy game"**

- **CASL Team: A unique lab-university-industry partnership**
  - **Industry (EPRI, Westinghouse, TVA)**
  - **National Laboratories (ORNL, LANL, INL, SNL)**
  - **Universities (MIT, NC State, Michigan)**



Advanced Modeling and Simulation of the Operating Reactor (aka "Virtual Reactor")

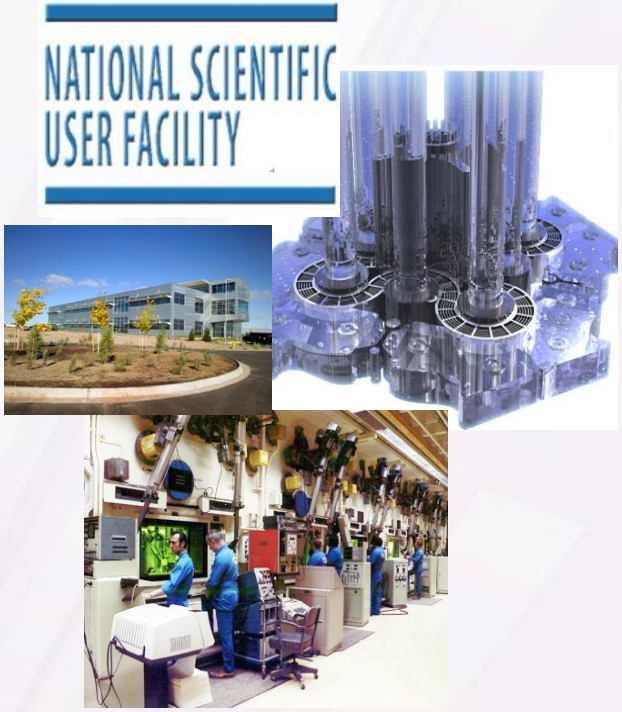
Transformative Nuclear Concepts R&D (FY 2012)

- Supports via an open, competitive solicitation process, investigator-initiated transformative projects
- High-risk, high-reward concepts
- Potential for significant leaps in advanced nuclear technology development
- Primary goals:
  - **Encourage identification and development of "outside-the-box" options in all aspects of civilian nuclear energy program**
  - **Ensure that good ideas have sufficient outlet for exploration**

- Covers full range of nuclear energy technology and not specific to any on-going mission activities
- Key mechanism in NE's R&D portfolio to further encourage transformative thinking and promote creative solutions to the universe of nuclear energy challenges and questions

National Scientific User Facility (FY 2012)

- Unique nuclear research facilities available for science-based experiments
  - **Mechanism for research organizations to collaborate, and conduct experiments and post-experiment analysis at facilities not normally accessible**
- Researchers introduced to new techniques, equipment, and personnel
- User Facilities:
  - **INL's Advanced Test Reactor and post-irradiation examination facilities of the Material and Fuels Complex**
  - **Research reactors at the Massachusetts Institute of Technology and North Carolina State University**
  - **Examination facilities at the Universities of Wisconsin, Michigan and Nevada-Las Vegas**



Summary

- NEET will develop crosscutting technologies that directly support and complement the Office of Nuclear Energy's (NE) development of new and advanced reactor concepts and fuel cycle technologies
- NEET will also encourage the development of transformative, "outside-the-box" solutions across the full range of nuclear energy technology issues.
- NEET program addresses critical technology gaps relevant to multiple reactor and fuel cycle concepts in a cost-effective manner that fosters collaboration and prevents overlap